TOWN OF IPSWICH
UTILITIES DEPARTMENT

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June 4, 2015

Thomas Mahin
MassDEP Northeast Regional Office
205B Lowell Street
Wilmington, Massachusetts 01887

RE: Ipswich Manganese Compliance Action Plan
PWS ID #: 3144000

Dear Mr. Mahin,

In response to your letter dated December 8, 2014, the Town of Ipswich respectfully submits the following required Manganese Compliance Action Plan.

Since receiving the Manganese Advisory in October 2013, the Ipswich Water Department has worked diligently to manage its sources that are high in Manganese to protect its customers from increased exposure. Ipswich has cooperated with DEP and has voluntarily taken several steps to reduce Mn levels in the water distribution system.

Ipswich also retained a consultant to assist in a Mn evaluation of the system. Several opportunities for improvement, identified while working with our consultant, have been completed or are currently underway, these include:

- Increased sampling for Iron and Manganese (total and dissolved)
- Modifications to limit operation of Browns and Fellows Road Wells
- Modifications to improve blending of various source water
- Installation of a variable frequency drive (VFD) on Browns Well pump
- Surface and ground water sampling around Browns Well

The following plan will detail steps taken to manage Browns Well and Fellows Road Well to minimize Manganese levels, as well as options being evaluated to specifically address Manganese at Browns Well.

Browns Well will be the primary focus of Manganese analysis for several reasons, including: higher levels of Manganese, greater pumping capacity, location within the Parker River Watershed and wellhead age. Funding availability will be a factor impacting actions at both sources.

Please feel free to contact me to discuss this action plan further. I can be reached at 978-356-6635 ext. 2108 or vhalmen@ipswichutilities.org.

Sincerely,

Vicki Halmen
Water & Wastewater Director

Ipswich Water Department
PWS ID #: 3144000
Manganese Compliance Action Plan

The following plan is currently being implemented in order to reduce the Mn levels in the distribution system to 0.30 mg/L, or below.

Education:

In November 2013 Ipswich voluntarily sent a Mn Advisory to all its customers via mail and press release. Educational information is provided on the Ipswich Water Department website (http://www.ipswichma.gov/), including links to DEP and EPA's informational pages. Ipswich routinely provides Mn updates in the monthly Utilities Newsletter which is distributed to all water and electric customers with their monthly bill.

In order to notify new billing units of the advisory we will begin inserting a Mn alert section on the newsletter monthly. The alert section will direct customers to the Water Department website to find the advisory notice and provide addition contact information.

All required information continues to be provided in the annual Consumer Confidence Report (CCR).

Monitoring of Iron and Manganese at sources and in distribution system:

In October 2013 Ipswich began increased Iron and Manganese sampling (total and dissolved) from the distribution system and the two Ipswich water sources with elevated Manganese levels (Browns and Fellows Road Wells). Samples continue to be collected from the two wells daily, when in operation. Distribution system samples were collected monthly from DEP approved bacteria sampling locations, during the data collection phase of the evaluation. Ipswich will resume distribution system sampling following this schedule.

In addition, quarterly Mn sampling is being conducted per our DEP Sampling Schedule.

Optimization of existing treatment processes:

No treatment of Manganese is done at either source at this time. A sequestering agent in used at both wells, but is not considered a treatment option for removal of Manganese.

The surface water treatment plant (WTP) effectively treats Iron and Manganese. Average raw water Mn is 0.20 mg/L and is reduced to an average finish water value of 0.03 mg/L. This source supplies Ipswich with 50-60% of its water and is routinely blended with the five other groundwater sources.

Management of sources:

Daily sampling of Browns and Fellows Road Wells provides the necessary data to manage those sources effectively with the three other groundwater sources and the WTP to minimize customer exposure to Mn. When Mn levels increase in Browns and Fellows, those wells are taken offline to allow time for the aquifers to recover.

All water sources are managed using a SCADA system which monitors our primary water storage tank level. When this tank level drops, the system calls for wells to start up at pre-determined set-points to meet the increasing demand. The system has been reprogramed to call for Browns Well to operate last, Fellows Road Well next to last. Whenever these wells are activated, they are the first and second to be shut off, once the tank level returns.

In November 2014 a variable frequency drive was installed at Browns Well to provide flexible flow control. Since its installation, it has been set to run the well at 200 gpm (down from 400 gpm), providing a more consistent operation of the well over a longer period of time, while minimizing Mn spikes.

Use of other sources:

All six sources (five groundwater, one surface water treatment plant) are, and will continue, to be utilized year round and managed based on water quality, demand, watershed withdrawal limits and maintenance needs.

Blending of sources:

Operating six sources with three storage tanks allows the distribution system water to be blended to further reduce Mn exposure. If Mn levels increase significantly at Browns and Fellows, they are shut-down. If demand is such that those wells must run, they are managed as discussed above. When the wells are running to meet demand when they otherwise would not be running, the goal is to have other low Mn sources operating, to offer blending of source water.

All storage tanks, including the primary 3 million gallon Town Hill Tank, are typically filled and levels maintained by the WTP. The WTP supplies very low Mn water to the tanks which blends with well water when the WTP is off-line.

Connection to other PWS's:

Ipswich has interconnections with Rowley and Hamilton. These are emergency connections only and are not considered appropriate for long term use.

Treatment:

In December 2013, AECOM was retained to provide an evaluation of alternatives to reduce Manganese concentrations. AECOM's report on alternatives is found in Appendix A.

In November 2014, AECOM developed a scope of services (Appendix B) to further investigate Browns Well and the surrounding surface and ground water that is impounded by beaver dams. This scope is currently being executed.

Once the data from this effort is obtained and analyzed, Ipswich will assess its options with AECOM and DEP and determine an appropriate course of action.

APPENDIX A

Ipswich Utilities Department, Ipswich MA:

IPSWICH WELLS ACTION PLAN FOR MANGANESE CONTROL

Final Report

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APPENDICES

The enclosed report presents an action plan considering short term and long term measures to reduce manganese concentrations in the Town of Ipswich water distribution system.

1.0 BACKGROUND

The Water Department operates a combined surface water and groundwater drinking water supply system. Figure 1 illustrates the water system sources for the Town of Ipswich. The surface water treatment plant (WTP) consists of conventional filtration and treats water from Bull Brook and Dow Reservoirs. The WTP production is typically 1600 gallons per minute (gpm) and operates 10-12 hours per day. A 14-inch transmission main is located between the WTP and the 3 million gallon (MG) Town Hill Tank. The WTP operates based on this tank level. The WTP is taken off-line night, weekends, and Holidays. To supplement the WTP and to provide water supply when the WTP is off-line, the Water Department operates up to 5 groundwater wells. The largest capacity wells are the Fellows Well at 230 gallons per minute (gpm) and Browns Well at 400 gpm. The Water Department estimates that the water distribution system is supplied with a ratio of 45 % groundwater and 55 % surface water, on an annualized basis.

In the Fall of 2013, the Water Department received a form letter from the Massachusetts Department of Environmental Protection (MADEP) regarding manganese. This letter is enclosed in Appendix A. This letter was distributed to public water utilities in Massachusetts in an attempt to raise awareness regarding manganese, especially for systems with elevated levels of manganese in exceedance of the health advisory limit of 0.3 milligrams per liter (mg/L). Although manganese is a secondary contaminant, the standard is relatively low (0.05 mg/L) and there is evidence that exposure to concentrations above 0.3 mg/L, over a period of years, may lead to developmental problems in children. The groundwater wells in Ipswich are not equipped with the means to remove manganese, and the concentrations have ranged from a low of 0.02 mg/L to nearly 0.7 mg/L on average. Although there is currently no regulatory action being enforced by MADEP, and there are no anticipated changes to the standard, the Town of Ipswich has engaged AECOM to develop an action plan in response to the health advisory.

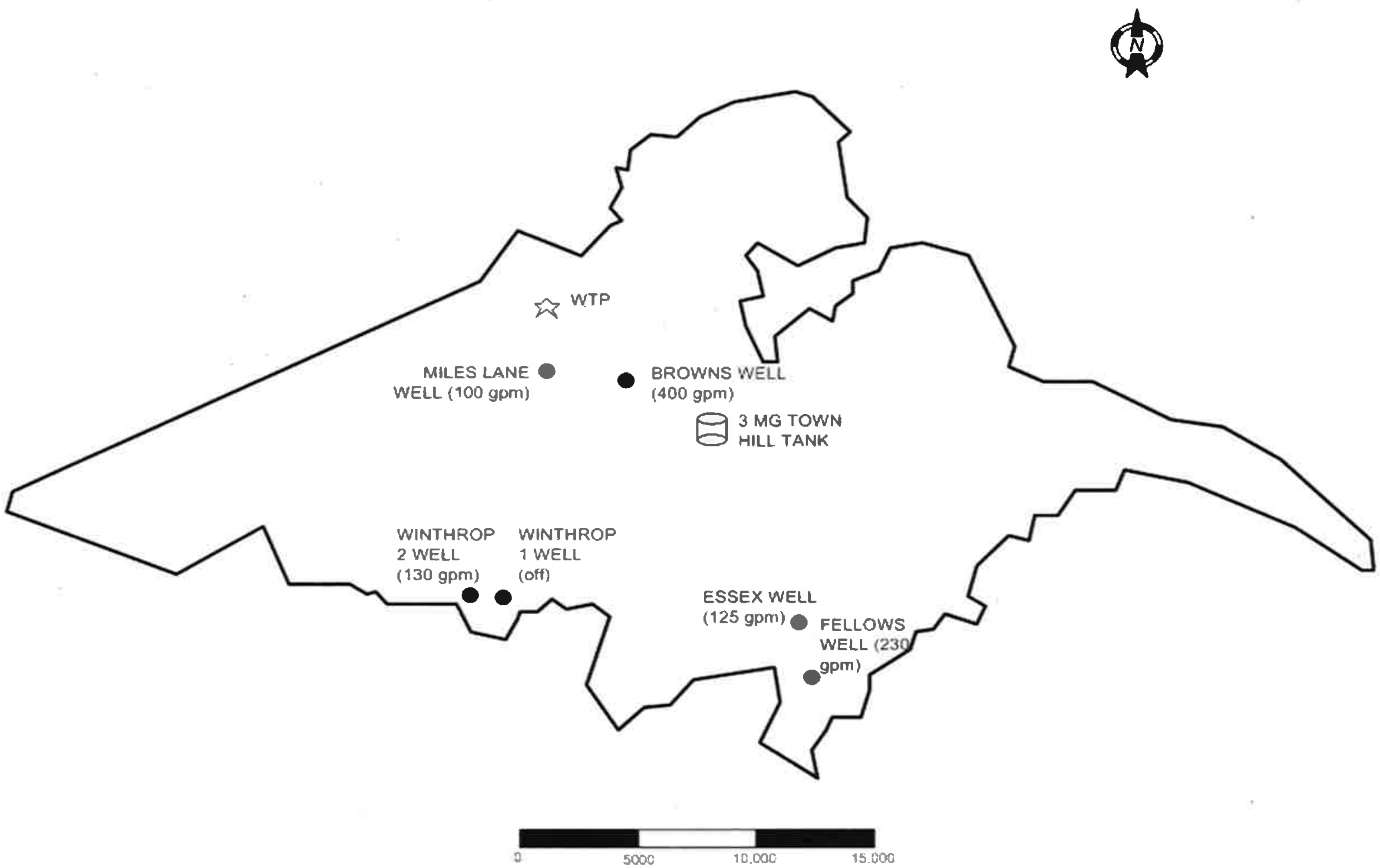


Figure 1. Approximate Location of Water Infrastructure, Town of Ipswich MA.

Iron and manganese in the natural environment are often in their simplest forms, namely ferrous iron (Fe^{2+}) and manganous manganese (Mn^{2+}). These are both dissolved states and are therefore present as aqueous compounds. Once oxidized via exposure to an oxidant (air, chlorine, ozone, permanganate, etc.) the dissolved state is converted to a particulate or "insoluble" compound which can then be removed in a filter or allowed to settle out in a clarifier if available. In the distribution system, however, these insoluble products are transported to consumer's homes where the metals are responsible for staining, discoloration, metallic taste, and general aesthetic issues.

The MADEP has contacted the Town to inquire about the Water Departments plan to address manganese concentrations in the water supply when concentrations exceed 0.3 mg/L. In response, the Town had suspended operations of Browns Well and in an earlier attempt to maintain water quality, the operation of Winthrop 1 well was officially inactivated (in 2011) with no plans to re-activate. However, removing wells from service is not a long term solution because these wells (particularly Brown's Well) are major contributors to the demand, and permanently removing these wells form service will place additional burden on the WTP and on the other wells.

Manganese is also present in the WTP source water. The source of iron and manganese is the Dow Reservoir, an impoundment supplied by Bull Brook. Often, manganese found in surface waters is in the dissolved state, as a result of anaerobic conditions that exist when the water is depleted of dissolved oxygen which is common during the summer months. Benthic sediments at the bottom of an impoundment will also deplete oxygen levels, further creating anaerobic conditions. Thus, reservoir turnover can transport the dissolved manganese from the lower anaerobic depths to the water surface as the colder surface water and warmer deeper water exchange locations. Intakes that are at mid-depth or near the surface will then pull in the dissolved manganese. This is a common occurrence in many New England reservoirs. However, the concentration of manganese in the WTP finished water is generally well below the secondary standards due to the "fine tuning" of the WTP unit processes that the WTP staff routinely practice.

In summary, the Water Department seeks to establish an action plan for addressing the manganese issue. In this report, AECOM presents an action plan, considering short term and long term measures. In the short term, AECOM recommends that the Water Department institute a program to address manganese by maximizing the WTP blending, and maximize the use of the better quality wells as practical, and controlling the rate of well water pumping from the poor quality wells. Well cleaning and maintenance programs are recommended, along with a groundwater sampling program to help fully characterize the groundwater quality. In the long term, AECOM has prepared an analysis of treatment options and presents the preferred option along with conceptual level construction costs.

2.0 SURFACE WATER AND WELL WATER OPERATIONS

Compared to the wellwater, the quality of the finished water from the WTP is generally better with respect to manganese. There is no treatment of manganese for the wells. The well water is dosed with chlorine for disinfection, fluoride for dental caries, and an orthophosphate-polyphosphate blend for sequestration and corrosion control.

2.1 Current Well Water and Surface Water Blending. Table 1 below summarizes the capacity and typical iron and manganese concentrations from the wells. It is noted that, historically, there is very little well water quality sampling data to review. The data in table were compiled from relatively infrequent grab sample analyses as conducted by the Water Department. AECOM recommends that additional sampling be conducted, to better inform the alternatives analysis (as discussed in Section 3 of this report).

Table 1. Summary of Groundwater Wells.

Well Designation	Capacity (gpm)	Iron (mg/L)* (Range) [average value]	Mn (mg/L)* (Range) [average value]	Comments
Browns	400	(0.02-0.28) **[0.16]**	(0.26-1.11) **[0.70]**	25 HP submersible well pump, no VFD
Miles	100	(0.02-0.04) **[0.03]**	(0.02-0.032) **[0.024]**	10 HP submersible well pump, no VFD
Essex	125	(ND-0.02) **[0.01]**	(0.028-0.038) **[0.035]**	40 HP vertical turbine well pump, with VFD
Fellows	230	(0.01-0.03) **[0.02]**	(0.396-0.537) **[0.50]**	40 HP vertical turbine well pump, with VFD
Winthrop 1	Offline	No data	No data	No data
Winthrop 2	130	(0.03) **[0.03]**	(0.039-0.043) **[0.041]**	15 HP submersible well pump, with VFD

**Based on limited sampling data*

The USEPA Secondary Maximum Contaminant Levels (SMCL's) for iron and manganese are 0.3 mg/L and 0.05 mg/L, respectively. As shown in the table above, iron concentrations in raw well water are below the SMCL's, even where manganese is considerably above its respective SMCL of 0.05 mg/L. Further, the data show that the Miles Lane, Essex, and Winthrop 2 wells presently meet the SMCL for iron and manganese (i.e., without the need for treatment). The Miles Lane well, in particular, has the best water quality.

The MADEP has a policy on the removal of manganese. According to MADEP, if the manganese concentration exceeds 0.3 mg/L but is normally less than 1.0 mg/L, an assessment by the MADEP Office of Research and Standards is necessary to determine if treatment is required. If the manganese concentration normally exceeds 1.0 mg/L, or if the combination of iron and manganese exceeds 1.0 mg/L, MADEP's policy is to require treatment. Through discussions with MADEP, the Water Department has been advised that the manganese concentrations are not considered high enough so as to warrant treatment. Often, however, the need for treatment of manganese is driven by the nature and number of consumer complaints.

The iron and manganese concentrations from the WTP are shown in Table 2, as summarized from operating data from 2013.

Table 2. Average and [Ranges] of Monthly Values of Fe and Mn from the Ipswich WTP (2013).

Month	Fe (mg/L)	Mn (mg/L)
January	**0.018** [0.01-0.03]	**0.021** [0.015-0.028]
February	**0.013** [0.01-0.02]	**0.019** [0.015-0.029]
March	**0.010** [ND -0.02]	**0.013** [0.004-0.023]
April	**0.013** [ND -0.02]	**0.009** [0.006-0.013]
May	**0.014** [0.01-0.02]	**0.011** [0.009-0.016]
June	**0.008** [ND -0.02]	**0.029** [0.017-0.041]
July	**0.011** [ND -0.02]	**0.024** [0.018-0.062]
August	**0.014** [ND -0.02]	**0.024** [0.012-0.035]
September	**0.008** [ND - 0.02]	**0.023** [0.009-0.039]
October	**0.010** [ND - 0.01]	**0.015** [0.01-0.018]
November	**0.004** [ND - 0.01]	**0.022** [0.013-0.032]
December	**0.006** [ND -0.02]	**0.028** [0.022-0.033]

Average Fe = 0.011 mg/L **Average Mn = 0.02 mg/L**

These data were summarized from the monthly operating reports as submitted to MADEP. As shown, iron concentrations are well below the secondary standard of 0.3 mg/l and manganese is also comfortably below the secondary standard of 0.05 mg/L. This suggests that the treatment practices at the WTP have been effective in controlling raw water iron and manganese.

In addition to differences in water quality, the surface water treatment plant and the groundwater wells vary in capacity. With a capacity of 1600 gpm, the surface WTP can produce a much higher volume of finished water compared to the wells, approximately double that of all wells combined. Table 3 shows the monthly cumulative flow volumes from all sources, based on 2103 pumping data.

Table 3. Cumulative Monthly Flow Volumes for each Source (2013).

DATE	BROWNS	ESSEX	WIN #1	WIN #2&3	MILE LN	FELLOWS	PLANT	TOTAL
January	1,376,900	1,184,000	0	418,800	539,840	2,947,800	17,315,100	23,782,440
February	3,105,100	1,198,300	0	207,900	1,173,464	662,700	15,679,300	22,026,764
March	1,806,500	2,516,200	0	55,800	1,703,160	1,085,400	17,710,700	24,877,760
April	4,679,800	2,304,900	0	219,800	2,019,168	4,294,700	12,338,700	25,857,068
May	3,964,400	2,707,500	0	245,900	2,867,168	3,819,100	18,192,900	31,796,968
June	4,547,900	1,677,100	0	909,600	1,352,061	3,842,300	17,163,000	29,491,961
July	5,176,900	2,232,000	0	734,200	0	5,703,600	20,936,800	34,783,500
August	5,541,000	3,232,800	0	1,087,700	0	6,824,600	17,947,500	34,633,600
September	4,798,600	4,580,400	0	1,293,300	611,964	4,783,400	14,612,100	30,679,764
October	4,414,700	4,254,000	0	757,000	3,063,350	5,888,600	10,393,200	28,770,850
November	929,100	3,859,800	0	3,152,900	2,789,734	4,290,700	11,380,900	26,403,134
December	93,100	5,218,000	0	5,449,500	3,199,879	4,944,800	7,849,000	26,754,279
TOTAL	40,434,000	34,965,000	0	14,532,400	19,319,788	49,087,700	181,519,200	339,858,088
Max	5,541,000	5,218,000	0	5,449,500	3,199,879	6,824,600	20,936,800	34,783,500
Avg	3,369,500	2,913,750	0	1,211,033	1,609,982	4,090,642	15,126,600	28,321,507

According to Table 3 data, the average daily demand is 0.94 million gallons per day (mgd) and the maximum average monthly demand was 1.16 mgd (occurring in July). Looking at these same data in a different way, Table 4 shows flow contributions from each source as a percentage of the total flow, based on a monthly cumulative flow volumes. These flow data are recorded annually in order to comply with registered and permitted withdrawal allowances. The WTP, Browns Well, and Miles Lane Well are in the Parker River Watershed, from which the Town has registered withdrawal allowances of up to 640,000 gpd and a permit for an additional 340,000 gpd for a total of 980,000 gallons per day. The Fellows, Essex, and Winthrop Wells are in the Ipswich River Watershed with a registration for only 200,000 gallons per day. Therefore, the Water Department must continue to carefully manage not only water quality from the various sources, but also the quantity of withdrawal.

As shown in Table 4, the well water contribution to the total flows can vary considerably, depending on the season and the demands. In 2013, the highest well contribution occurred from September through December. Higher well use will introduce higher concentrations of manganese into distribution, especially if this includes Browns and Fellows wells. Winter months seem to coincide with the increased use of Essex, Winthrop, and Miles Lane Well (the better wells) presumably because winter demands are lower and these better wells with lower yields can accommodate the lower flows. In summer, the larger wells are utilized due to their increased capacity and the increase in demands, but this comes at the expense of reduced water quality.

Table 4. Seasonal Variations in Flow Contributions from the WTP and Wells (2013).

MONTH	BROWNS	ESSEX	WIN #1	WIN #2&3	MILE LN	FELLOWS	PLANT	TOTAL
January	6%	5%	0%	2%	2%	12%	73%	100%
February	14%	5%	0%	1%	5%	3%	71%	100%
March	7%	10%	0%	0%	7%	4%	71%	100%
April	18%	9%	0%	1%	8%	17%	48%	100%
May	12%	9%	0%	1%	9%	12%	57%	100%
June	15%	6%	0%	3%	5%	13%	58%	100%
July	15%	6%	0%	2%	0%	16%	60%	100%
August	16%	9%	0%	3%	0%	20%	52%	100%
September	16%	15%	0%	4%	2%	16%	48%	100%
October	15%	15%	0%	3%	11%	20%	36%	100%
November	4%	15%	0%	12%	11%	16%	43%	100%
December	0%	20%	0%	20%	12%	18%	29%	100%
						Average =	**54%**	

The 2013 use patterns were not necessarily typical due to several factors such as extended shut-downs, GAC media replacement, limited plant use due to the lagoons being near capacity, but in general the annual average WTP contribution of 54% is consistent with previous years. Generally, WTP and well blending is practiced during the weekdays, but on weekends the entire demand is met by the wells and tank storage because the WTP is off-line during this period. Further, depending on the time of year, weekend demands are heavily reliant on Browns and Fellows. Figure 4 shows the breakdown of well pumping contributions from weekend operations only. This figure shows that 80% of the demands are met by Browns and Fellows wells during weekend pumping during the summer months. Peak weekend demands of about 1.4 mgd (970 gpm) were recorded on September 28th, 2013.

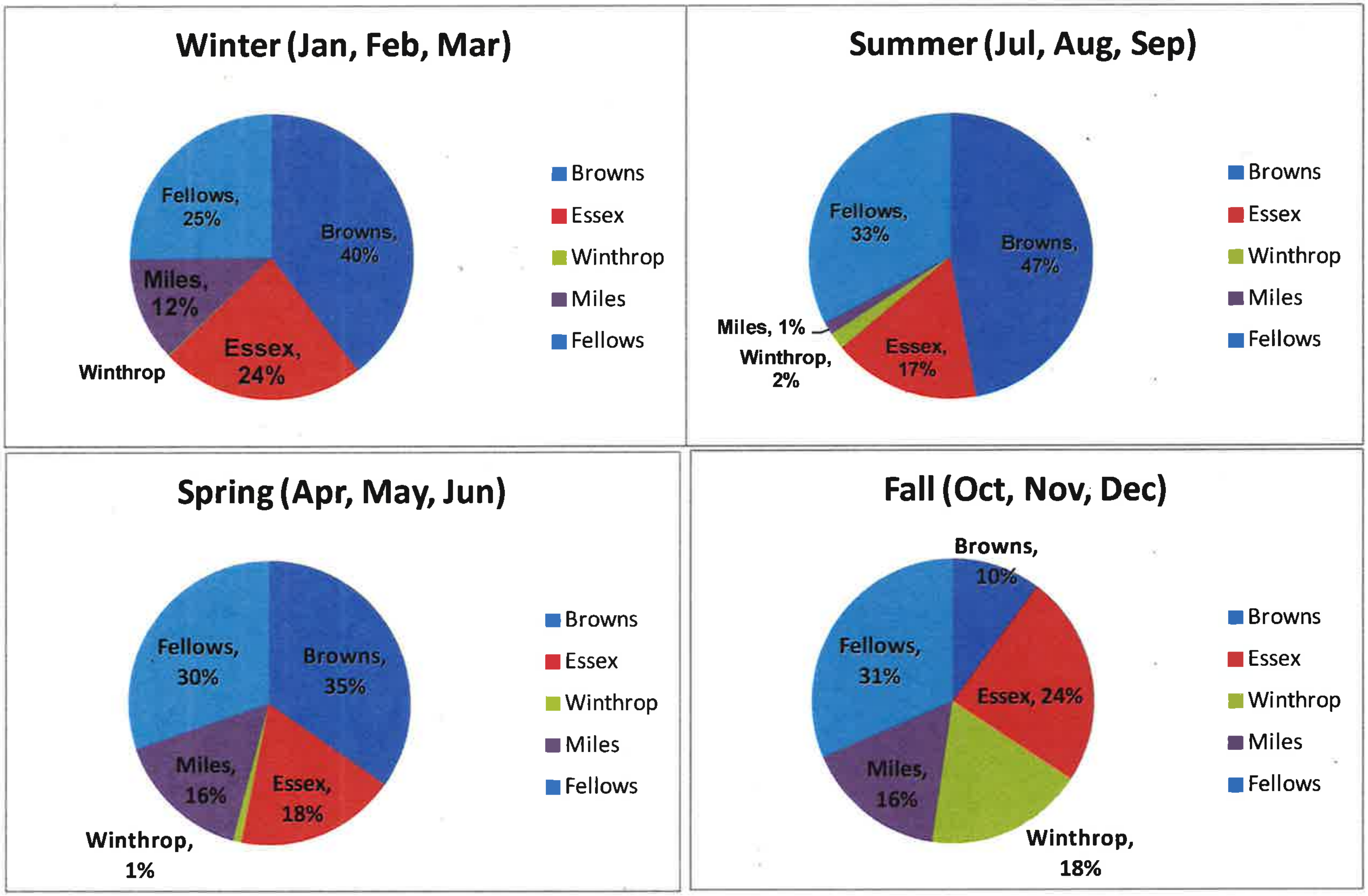


Figure 4. Seasonal Weekend Well Pumping Statistics from 2013, as % of Total Well Pumping (WTP not in service).

In summary, the existing WTP and well operations results in a blended supply, the extent of which can vary seasonally. The practice of blending the WTP supply and well water impacts the overall water quality in the distribution system. Table 5 summarizes the results of recent sampling events from different locations within the distribution system. Note that each sampling event was conducted mid-week, and therefore the data do not coincide with weekend operations.

Table 5. Recent Distribution System Fe & Mn Sampling Events.

Distribution Location	10/22/2013		11/19/2013		12/18/2013		1/8/2014		Average	
	Fe	Mn	Fe	Mn	Fe	Mn	Fe	Mn	Fe	Mn
Police Station	0.03	0.03	0.31	0.09	0.01	0.036	0.09	0.038	**0.11**	**0.049**
JNB	0.07	0.094	0.03	0.049	0.01	0.057	0.06	0.038	**0.04**	**0.060**
Central Fire	0.01	0.094	0.01	0.083	0.02	0.058	0.04	0.163	**0.02**	**0.100**
Topsfield Rd	0.01	0.019	0.02	0.021	0.08	0.047	0.04	0.04	**0.04**	**0.032**
Shaws	0.01	0.042	0.03	0.03	ND	0.038	0.01	0.045	**0.02**	**0.039**
Pinefield Tank	0.03	0.025	0.02	0.03	0.04	0.034	0.11	0.045	**0.05**	**0.034**
Ipswich Ford	ND	0.269	0.01	0.2	0.01	0.07	0.02	0.314	**0.01**	**0.213**
Ascot Stables	0.02	0.023	0.03	0.037	0.01	0.04	0.13	0.024	**0.05**	**0.031**
Utilities Office	ND	0.023	ND	0.019	0.01	0.053	0.95	0.088	**0.48**	**0.046**
Wolf Hill	0.12	0.019	0.09	0.029	0.08	0.023	0.05	0.032	**0.09**	**0.026**
Plover Hill	0.07	0.037	0.01	0.026	0.03	0.035	0.03	0.098	**0.04**	**0.049**
Averages	0.04	0.061	0.06	0.056	0.03	0.045	0.14	0.084	0.09	0.061

The sampling events summarized in Table 5 are only "snapshot" characterizations of the distribution system iron and manganese levels. Much more data would be needed in order to make any attempts to statistically correlate distribution system water quality with well pumping practices. However, the data generally indicate that there is a range of iron and manganese concentrations within the distribution system, as expected. Iron is well below the 0.3 mg/L SMCL and manganese is problematic in only certain locations such as Central Fire, JNB, and (especially) Ipswich Ford off of County Road. It is noted that these locations are near the center of Town, and may have a higher influence from Browns Well than other locations such as Plover Hill on Great Neck and Topsfield Road which are further away from Browns and Fellows Wells and thus under reduced influence by the lower water quality.

2.2 Short Term Recommendations for Minimizing Manganese Concentrations. As in other communities, the presence of manganese in the distribution system has an impact on customer satisfaction. According to the Water Department staff, customer complaints often coincide with periods when the WTP is off-line, which would be expected due to the differences in water quality between the WTP and the wells. Complaints are often related to dirty water and staining. Distribution system dead-ends (for example, the Line Brook area) are prone to complaints, in particular, if flushing is not routinely practiced.

An obvious solution to the manganese issue (in lieu of groundwater well treatment systems) would be to operate the WTP and only the better quality wells (Winthrop, Miles Lane, and Essex) as needed to meet demands, and not utilize Browns or Fellows Wells at all. However, all wells are sometimes needed to satisfy the demands, and the WTP has other operational constraints that require periodic resting of the facility. For example, the residuals lagoons at the WTP are often at capacity and can be a limiting factor in the operation of the facility. Additional WTP operation will compound this problem. Problems with filter media exhaustion and replacement costs and other high operating expenses further require resting of the facility. Even if these problems did not exist, the WTP staff have commented that the source water reservoir does not have the safe yield to adequately sustain the WTP with flows higher than are currently being delivered. Additional use of the WTP will require additional staffing with subsequent increases in operating costs. Further, complying with permitted withdrawals from the Parker River and Ipswich River basins must also be considered. The Winthrop, Essex, and Fellows wells are within the Ipswich River Watershed Wells, a very sensitive and heavily monitored natural resource.

In summary, although increase use of the WTP is part of the solution, other measures should also be integrated into the short-term plan. The following listing summarizes the short-term recommendations.

1) <u>Minimize the Practice of Placing the WTP in Idle</u>. Although this is an obvious strategy, as much as possible (and in consideration of the WTP constraints noted above) it is

recommended that the Water Department minimize the practice of operating Browns and Fellows wells at maximum capacity without also operating the WTP. This is especially important during weekends when demands are high, because it is not possible to meet peak weekend demands (which are nearly 1000 gpm) without using Browns and Fellows wells. Instead, the Water Department should adopt a policy to utilize the WTP during these periods and minimize (or suspend) operations of Browns and Fellows well.

2) In planning for placing the WTP in idle, first fill the Town Hill Tank. When it is necessary to place the WTP in idle, operators should ensure that the 3 MG Town Hill tank is filled first. It is understood that this is an existing standard operating practice; however, a variation of this practice would be to top of the tank with finished water from the WTP only, if possible depending on demands. It is understood that at times, the WTP alone cannot fill the tank and Browns Well and/or Fellows well are needed to assist. But if demands are lower, filling only from the WTP would be preferable. This will require that Browns well be idle during the filling of the Town Hill tank, but it will ensure that the tank will contain a full volume high quality supply for which to draw from when the WTP is idle. This can be used to blend with the wells or can be used exclusively. The Water Department may be required to modify the operating band on the tank so as to obtain more available supply.

3) Investigate the Integrity of the Browns Well Casing. Well cleaning logs had indicated that a hole was observed in the casing, near the top . This could be allowing low quality water that is nearer to the surface into the casing and then into distribution. Water near the surface can often contain higher dissolved oxygen, promoting oxidation to insoluble manganese. The Water Department should investigate this reported issue and make repairs.

4) Install a VFD on the Browns Well Pump. If necessary to operate only the wells, it will not be possible to satisfy the SMCL of 0.05 mg/L Mn unless the demands are below 344,000 gallons per day (gpd). In this scenario, Miles Lane would need to be operated at full rate to produce 144,000 gpd, and the 200,000 gpd balance made up from the maximum allowable withdraw from the Ipswich River watershed wells, namely, the Essex and Winthrop wells. Higher demands require the use of Browns and Fellows Wells. Currently, the Browns Well pump is

not equipped with a variable frequency drive (VFD) and is therefore operated at constant speed but the ability to operate Browns Well at a variable rate would be a tool that the Water Department can use to minimize manganese loadings to the distribution system, without sacrificing the capacity from Browns entirely.

5) Rotation and pumping of Water Supply Wells. Water supply wells generally provide better water quality if not pumped at a rate near their capacity. Pumping wells below their capacity over a longer period of time is preferred. Additional benefits generally include less frequent well cleanings and lower pumping costs. As discussed above, installing a VFD at the Browns Well with allow a lower pumping rate and more efficient blending of water from the WTP and other water supply wells.

6) Monitor Surface Water Levels near Supply Wells. Ponds, rivers and other surface waters can impact groundwater quality. Groundwater supply wells that obtain a portion of their recharge from surface water supplies can see an increase in iron and/or manganese quality. If increase water levels near a supply well occur from beaver dams or other causes, water quality should be monitored closely for increases in iron and manganese concentrations. If increases are noted, corrective measures should be taken. This is allowed through MA DEP water supply protection regulations. There is also greater potential for groundwater supplies being under the influence the closer surfaces waters are to the supply well. A groundwater supply well under the influence would require additional treatment prior to distribution.

7) Optimization of Sequesterant Dosing. Sequestering can be a fairly reliable tool for controlling the effects of insoluble manganese. Sequestration (or chelation) is the ability of a chemical to form a complex bond with metal ions that allows these metal ions to remain in solution despite the presence of oxidizing agents (i.e., chlorine). Therefore, sequesterants mask the effects of dissolved iron and/or manganese by preventing them from oxidizing within the distribution system and causing particulate manganese. In order to maximize the use of this chemical (the Ipswich Water Department uses AquaMag, a Carus product), operators should continue with the existing practice of using the sequesterant supplier for

routine checks on the dosing levels and distribution system monitoring. Also, operators should continue with the existing practice of monitoring of AquaMag supply volumes, check interlocks for proper pacing, and perform checks on the applied dose and resulting phosphate concentration to ensure that the desired dose is actually being supplied.

It should be noted that sequestering is not a guarantee for masking manganese and can be effected by certain unavoidable conditions. For example, hot water (as encountered in residential hot water tanks) will break down the sequesterant bond, releasing the metal and causing the discolored water. Also, proper contact time with the AquaMag, prior to the introduction of chlorine is important but at the Ipswich wells the buildings are so small that this contact time is not ideal.

8) <u>Practice routine flushing in areas of known consumer complaints.</u> Flushing of mains that are in proximity to areas of known customer complaints and hydraulic dead-ends is a good technique to minimize water age. High water age can impair the effectiveness of sequesterants because sequestration can only hold its bond for so long. Minimizing water age can help to maximize the effectiveness of sequestration.

9) <u>Institute a Well Water Sampling Program</u>. To date, water quality sampling from the wells and the distribution system has been relatively infrequent. Currently, well samples and distribution samples for bacteria are collected twice per month during and as part of the bacterial sampling conducted by the Water Department. Baseline iron and manganese from Browns and Fellows well are collected quarterly. This sampling is too infrequent to develop any trends that may occur as correlated with pumping practices and other seasonal effects (if any). Also, MADEP in their October 13 letter has requested that utilities begin developing baseline manganese concentrations at all points of entry into the distribution system. A sampling program will satisfy this request and will provide more extensive data in general, the benefits of which include:

    a. More data will better inform the dosing requirements of the sequesterants and other chemical feeds

b. Allow the Water Department to make decisions about well rotation
c. Data can be used for future design criteria for manganese treatment systems
d. More frequent sampling will alert the Water Department of changes to water quality that could be overlooked if sampling is less frequent

Another very important benefit of well water sampling is that wells that are technically inactive can retain their active status, as long as they are included in the sampling program. AECOM has confirmed this with MADEP (see correspondence in Appendix B). It is not necessary to collect bacteria samples from the well while it is offline, but the well in question must be pumped to waste before sample collection.

Section 3.0 of this Technical Memorandum describes the recommended sampling program and sample collection techniques.

3.0 RECOMMENDED WELL SAMPLING PROGRAM

Table 6 below shows the constituents and frequency of well water and distribution system sampling. These are considered the minimum number of samples. Additional sampling should be considered if time and staffing levels permit.

Wells that are idle should be included in this sampling program, unless the well is officially inactive with no plans to return to service. When sampling from a well that was in idle, it is recommended to operate to waste for a period (several minutes) in order to purge the well line and sampling line of deposits and generally old water which would be non-representative of the steady state conditions.

Table 6. Recommended Sampling Parameters and Frequency.

Parameter	Raw Well Water. Treated Well Water, Distribution Sampling*
	Monthly
Total Fe (mg/L)	X
Dissolved Fe (mg/L)	X
Total Mn (mg/L)	X
Dissolved Mn (mg/L)	X
pH (s.u.)	X
Alkalinity (mg/L $CaCO_3$)	X
Hardness (mg/L $CaCO_3$)	X
Turbidity (ntu)	X
Total Dissolved Solids (TDS) (mg/L)	X
Total Organic Carbon(TOC) mg/L)	X

It should be noted that the sampling recommendations include both total and dissolved iron and manganese. When measuring "total" metals, both the soluble (dissolved) and insoluble states are accounted for. Dissolved metals will stay in the soluble state unless they are oxidized (via chlorine, chlorine dioxide, oxygen, or other form of oxidant) and converted to insoluble metals. These particulates are responsible for consumer complaints. As noted, the role of the sequesterant is to hold the dissolved metals in solution and to block the action of the oxidant. (For this reason, the use of sequesterant must be applied prior to the dosing of chlorine.) Therefore, in both well water and in distribution system samples, an understanding of the fractionation of dissolved versus total metals will help to optimize the sequesterant dose and to measure the potential for customer complaints.

4.0 LONG TERM SOLUTIONS FOR IRON AND MANAGESE CONTROL

The short term measures as described in section 2 and 3 of this report can be expected to alleviate some of the aesthetic issues and customer complaints resulting from manganese concentrations. It should be acknowledged that these short term measures will place an additional burden on the existing water treatment plant unit processes, due to increased use of the WTP, and on staff due to increased operations support. For a more reliable and effective means of controlling manganese, the Town can consider installing physical treatment systems at select wells. This would also provide an increase in overall water supply system redundancy, whereby the wells and the WTP could operate independently but without any sacrifice in water quality.

Not all of the wells would necessarily require treatment. The Essex well, Winthrop Wells 2 & 3, and Miles Lane wells currently produce acceptable water quality without the need for additional manganese removal. Instead, the emphasis for potential treatment systems should be on Browns Well primarily, and Fellows Well secondarily. Both contain high concentrations of manganese and produce the largest volumes of water (but relatively low concentrations of iron).

4.1 Treatment Options for Fellows Well. In evaluating treatment options for Fellows Well, it is not considered feasible to pump this well water across Town for treatment at the existing WTP. The pipeline routes and extent are considered prohibitive. Instead, a more cost effective approach would be to install a pressure filter system located in the proximity of the Fellows Well. There are a number of filter media options that would be suitable for manganese removal. Each could be evaluated as part of a pilot study. At this time, however, our preliminary recommendation is to utilize Greensand filtration for removing manganese. The reasons for this recommendation are as follows:

- Greensand filter systems are non-proprietary and can be bid by several equipment suppliers, for competitive bidding
- Greensand is accepted by the Massachusetts Department of Environmental Protection (MADEP) as a proven and viable technology
- There are numerous Greensand Filter systems operating in New England and in Massachusetts
- Filters are usually operated at fairly high hydraulic loading rates, typically 5 gpm/ft^2 or higher
- Greensand filter systems can operate with minimal operator intervention, which will reduce O&M costs and allow for satellite operations

- Filters and filter systems can be modified for future conversion for obtaining pathogen removal credits, should this someday be required by MADEP
- The absence of high iron concentrations further favors Greensand. Iron concentrations above 2 or 3 mg/L is known to challenge this process, requiring frequent backwashing of filters. However, because the iron concentrations are well below 0.5 mg/L, the Greensand filters should be able to operate for extended periods without the need for frequent backwashing

AECOM has reviewed the natural resource areas in proximity to the Fellows Well, along with basic site features such as topography and property boundaries. Conceptual siting of a greensand treatment facility has been developed. At this stage, we feel that the following features of the Greensand treatment facility at Fellows well are most feasible:

- Site the facility at Fellows well location, in an upland location offset from the wetlands and flood zone. See Figure A for Fellows Well Option in Appendix C. The facility would be approximately 50 ft x 50 ft.
- The filter vessel sizing should accommodate the possibility of future supply from Essex Well, without the need for additional equipment. Figure A shows this future pipeline, routed easterly along Essex Road, southerly along Candlewood Road, and then westerly along Fellows Road. Routing of a future pipeline from Essex Well cross-county to Fellows Road would encounter issues with wetlands, 100-year flood zone, and private property.
- Part of the Fellows Road treatment facility project should include replacing the existing 6-inch main that extends from the connection with the 12-inch main opposite the NE Biolabs property , to the intersection of Candlewood Road and Fellows Road. This main has been prone to breaks, and upsizing from 6-inch to 8-inch will provide adequate backwash water supply.

4.2 Treatment Options for Browns Well. In contrast to the fairly limited number of options at Fellows Well, the Browns Well options are more numerous. The type of treatment process is influenced by the location of the proposed manganese treatment facility. The Browns Well water could be pumped to the existing WTP where many options would exist for treatment, or to a new groundwater treatment facility similar to as previously described for the Fellows Well.

Figure B in Appendix C illustrates the options identified for treating the Browns Well supply. It should be noted that this preliminary analysis assumes that the Miles Lane Well continues to operate as is, with no additional treatment. This is appropriate due to the very good quality of this water. Also, at only 100 gpm, its low capacity does not have a major influence on the overall distribution system water quality. An option (not shown in the Figure) that AECOM initially considered was to locate a groundwater treatment system at the Miles Lane well site, but this would require an extensive piping effort to transport the water from Browns Well to Miles Lane well. Other options are proposed instead as summarized below.

Option 1. This Involves constructing a new Greensand filter plant, to treat 400 gpm, at the lot adjacent to Maria Drive (Lot 104). The Browns Well water could be pumped to a facility located in this lot, and then directed back to High Street for connection to the existing 12-inch main.

Advantages

- New Greensand filter plant will reduce manganese from Browns Well, and the location could accommodate Miles Lane well in future, if necessary

Disadvantages

- Location will require extensive piping to and from the facility
- Access to facility would be from a Cul-de-sac in a residential area, creating potential concerns from residents

This location is not considered advantageous, primarily due to extensive piping needed along High Street (approximately 1800 LF), a very busy route with other existing utilities to contend with. The concern over chemical deliveries and worker access through the residential area is also a major obstacle.

Option 2. Lot 109 directly across from the Browns Well location is considered highly advantageous. Although this lot is bounded along the back by wetlands, it appears preliminarily that there is enough available space to construct a Greensand treatment facility. The facility would be approximately 50 ft x 50 ft , slab on-grade construction.

Advantages

- The site would require very minimal piping in High Street, resulting in the lowest cost alternative
- The residuals could be directed to the sewer system in High Street (again, reducing cost)
- The filter washwater could be partially supplied by the 14-inch or 12-inch distribution system piping in High Street
- Because of the very limited friction head imparted by the well supply line to the new Greensand plant, the existing well pump head may potentially be adequate
- This stand-alone facility provides true redundancy to the water supply system as a whole
- Operation of this facility would be almost identical to operation of Fellows Well treatment systems (if also installed), allowing for ease of operations

Disadvantages

- Site is bounded in back by wetlands according to Mass GIS mapping. True wetlands survey would need to confirm actual proximity of wetlands and subsequent wetlands buffer.
- Site is low-lying, with potential for high groundwater
- This option does not address any existing problems at the water treatment plant.

Option 3. This Involves constructing a treatment process at the site of the existing WTP. Sub-options include:

- Building a pre-oxidation basin to oxidize manganese with potassium permanganate, from both Browns Well and the existing surface water supply. The manganese would settle in the existing clarifier along with coagulant sludge and turbidity. This option does not provide system redundancy, however, since the existing WTP unit processes would be required.

- Build a Greensand filter building at the site of the existing WTP for the Browns Well water only, and blend this filtered water in the clearwell of the surface water treatment plant. The combined water would be pumped to distribution as is normally practiced. If the surface water system were off-line, the clearwell and high service pumps (and existing post-treatment chemicals) would still be in service. This is better than the oxidation tank concept with regard to redundancy, but still is reliant upon the existing clearwell, high lift pumps, and existing post-treatment chemical feed systems.

- Another option at the WTP is to dose an oxidant into the Browns Well water, at Browns Well, and use the pipeline travel time for oxidation detention time. This water would enter the existing surface water treatment plant rapid mix, for coagulation, flocculation, and settling. The pipeline, when out of service, would be prone to deposition and would require frequent flushing.

Each of these options would require a blow-off line to the lagoons, as well as an option to discharge to the reservoir (pending regulatory approval).

<u>Advantages</u>

- Treatment at the site of the existing WTP would allow for centralized operations (although the Fellows well system would still have a separate treatment facility)
- Sharing of infrastructure could help to reduce cost (lagoons, backwash water supply, chemicals)
- A new Greensand filter plant (if selected) could be oversized to accommodate new space for the existing staff, for example, lab space, storage, control room, etc.

<u>Disadvantages</u>

- Location will require 5700 LF of piping in High Street
- Browns Well pump head may not be capable of overcoming friction in 8-inch line plus static lift through new Greensand facility
- Some loss of system redundancy will occur
- New process will add an additional residuals load to existing lagoons

These sub-options are all based on piping the Browns well water to the existing facility. The extent of this piping would be on the order of 5700 LF, all within High Street which is heavily traveled and contains a number of existing underground utilities. Constructing this pipeline would add cost and complexity to any of these Option 3 sub-options.

For the long term options and based on our preliminary assessment of existing conditions (approximate wetland locations and property lines) AECOM recommends a treatment facility for Browns Well . AECOM recommends locating a treatment system at Lot 009. Figure C in Appendix C shows this lot, and the conceptual location of the treatment facility. At this time, Lot 009 conceptually offers the lowest cost option, and maximizes system redundancy. Fellows Well would also benefit from treatment, although the greatest improvement in overall water distribution quality would be realized by a treatment system at Browns Well. If constructed, it is recommended to treat the Fellows Well supply initially but with the ability to take in the Essex Well water at a later date.

4.3 Conceptual Construction Cost Estimates for Greensand Treatment Systems at Fellows Well and Browns Well. Table 7 shows a summary of the preliminary planning level cost comparisons based on preliminary site assessments as described above. Unit prices for excavation, concrete, backfill, and piping were used based on 2013 RS Means construction cost data and labor rates (ENR of 9689) and include a 20% allowance for contractor overhead and profit, a 30% allowance for final design elements, and a 40% allowance for engineering and contingencies. Where available, cost information from recent projects were used for equipment and instrumentation, with RS means used for equipment not quoted by vendors or without recent project pricing. It should be noted that opinions of construction costs, at this level of detail, represent AECOM's best judgment based on experience and available information. As such, AECOM has no control over costs of labor, materials, equipment or services furnished by others or over market conditions.

Table 7. Summary of Concept Level Costs for Greensand Treatment Systems (2014 dollars).

	Browns Well	Fellows Well & new 8-inch Water Main on Fellows Road	Fellows and Essex Wells & new 8-inch Water Main on Fellows Road
Major Construction Cost Items	New WTF at Lot 009	New WTF at Fellows Well without Essex Well	New WTF at Fellows Well with Essex Well
Sitework	$428,200	$915,900	$1,893,400
Process	$645,000	$659,000	$654,900
Facility	$528,000	$570,900	$525,500
Electrical, Instrumentation and Controls	$247,900	$253,600	$248,200
Cost Breakdown			
Construction Sub-Total	**$1,849,000**	**$2,399,000**	**$3,322,000**
Contractor Overhead and Profit (20%)	$370,000	$480,000	$664,000
Final Design Elements (30%)	$666,000	$864,000	$1,196,000
Engineering & Owners Contingency (40%)	$1,154,000	$1,497,000	$2,073,000
Piloting	$30,000	$30,000	$30,000
Total Conceptual Cost	**$4,069,000**	**$5,270,000**	**$7,285,000**

At Browns Well, it is assumed that the treatment facility will be located at Lot 009, very near the existing well. The proximity to a sewer system will allow for disposal of backwash residuals residuals to the sewer, and will greatly minimize the amount of new piping needed to facilitate the treatment plant. The following elements are included in the construction subtotal:

- Greensand filter skid with face piping and controls (see Appendix D for Greensand filter proposal and filter profile and conceptual building layout). Skid is based on a duplex arrangement with (2) 7-ft diameter filters to operate at 5.2 gpm/ft^2 . Proposal includes media, air scour blowers, and control panel.
- Site work and concrete work for a new 2500 SF pre-engineered building, perimeter fencing, paving, clearing, and landscaping. Allowance for stormwater controls and wetlands protection.
- Chemical feed system and containment for fluoride (to match existing), phosphate (for corrosion control), sodium hydroxide (for adjusting pH to promote Greensand operation), and sodium hypochlorite (for Greensand regeneration and for chlorine residual).
- Piping for raw water supply, backwash water supply from the distribution system, spent filter washwater forcemain to sewer, and filtered water connection to distribution system.

- Allowances for electrical connections, instrumentation, and transformer upgrade.
- 10,000 gallon collection tank for spent filter washwater, and a discharge pump and forcemain to dispose of washwater to sewer.

At Fellows Well, the same treatment plant basic features would be installed, with the following exceptions

- The filters would operate at a moderate loading rate of 3.3 gpm/ft^2 .
- Since there is no sewer available at this location, the spent filter washwater would be collected in an underground tank and recycled back to the filter inlet for re-treatment, and the solids that settle in this tank would need to be periodically hauled off-site for disposal.
- The water main in Fellows Road has been prone to breakage and is undersized. The cost estimate includes a replacement and up-size of this line, from 6-inch to 8-inch. This will allow the line to adequately provide backwash water as well.

As noted, an option at Fellows Well includes the ability to tie-in the 125 gpm supply from Essex Well, which would bring the total treated capacity from 230 gpm to 355 gpm. This which result in a filter hydraulic loading rate of up to 5 gpm/ft^2 . The work would add cost from the installation of a 7,200 linear feet (LF) of 4-inch ductile iron piping routed along Essex Road, Candlewood Road, and Fellows Road.

As shown in Table 7, the concept level costs are in the range of $4.1 M to $7.2 M, depending on the option. This includes the cost for a pilot study, approved by the MADEP, which would confirm loading rates and provide design criteria. After the pilot study is completed, a preliminary design would be conducted in order to developing planning level cost for which to appropriate funding for the project. A more concise cost estimate would be developed at the preliminary design stage. This would be followed up with a final design and permitting effort for final MADEP approval.

END

APPENDIX A

MADEP MANGANESE MONITORING NOTICE TO WATER SUPPLIERS (OCT 2013)

MassDEP

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

DEVAL L. PATRICK
Governor

RICHARD K. SULLIVAN JR.
Secretary

KENNETH L. KIMMELL
Commissioner

IMPORTANT NOTICE

October, 2013

Re: Manganese monitoring

Dear Public Water Supplier,

As part of a continued effort to use the most up-to-date information to protect public health, the Massachusetts Department of Environmental Protection (MassDEP) is announcing a new outreach initiative designed to raise awareness regarding manganese in public drinking water. Recent studies[1] have identified public health risks associated with the ingestion of elevated levels of manganese, especially among infants and young children. These same studies suggest that in some cases, the concentration of manganese in drinking water can represent a significant contribution to an individual's daily intake. Therefore, as a precaution, MassDEP believes that it is prudent for Public Water Suppliers (PWS) to understand what levels of manganese may be in their water supply so they are prepared if and when customers contact them requesting such information. Some PWS may find that they need to take additional measures in order to limit undue exposure to the more sensitive population of consumers served. Extra measures may include: additional monitoring and reporting; informing and educating the public; and in an extreme case adding treatment.

Manganese is a common naturally-occurring mineral found in rocks, soil, groundwater, and surface water. Manganese is a natural component of most foods and it is an **essential** trace mineral in our diets. The principal source of exposure to manganese is from food, but drinking water can contribute to an increase in the overall intake of manganese. The U.S. Department of Agriculture's (USDA) recommended dietary allowance is 1.8 - 2.3 milligrams per day (mg/day) for adults. Grains and beans particularly provide manganese in our diets. For example, a cup of cooked enriched white rice contains 0.75 milligrams (mg) of manganese. Studies indicate that infants may not process manganese as well as older children and adults. Formula fed infants or children may consume more manganese than the rest

[1] For a list of these recent studies, please see: "REFERENCES: MANGANESE IN DRNKING WATER" posted on the MassDEP website at http://www.mass.gov/eea/agencies/massdep/water/drinking/lead-and-other-contaminants-in-drinking-water.html#9 .

of the family especially if they are fed with formula that is fortified with manganese and the formula is prepared with water that also contains manganese.

Currently, manganese is included on the list of federal and state Secondary Maximum Contaminant Level (SMCL) for drinking water. The SMCL for manganese is 0.05 milligrams per liter (mg/L), equivalent to 50 micrograms per liter (μg /L), based on aesthetics. When concentrations are greater than 0.05 mg/L, the water may be discolored and taste bad. In addition the U.S. Environmental Protection Agency (USEPA) and MassDEP have established public health advisory levels for manganese in drinking water. The health advisory levels are much higher than the SMCL, so that you are likely to have aesthetic problems with your drinking water prior to reaching the health advisory levels. Over a lifetime, the USEPA recommends that people drink water with manganese levels less than 0.3 mg/L (300 μg/L) and over the short term, USEPA recommends that people limit their consumption of water with levels over 1.0 mg/L (1000 μg /L). Children up to 1 year of age should not be given water with a manganese concentration over 0.3 mg/L (300 μg /L), nor should formula for infants be made with that water for longer than 10 days.

As part of this outreach initiative on manganese, the MassDEP, in conjunction with the Massachusetts Department of Public Health, is sending out information on the USEPA manganese health advisory to all health professionals overseeing the care of young children and pregnant women. As a result, you may receive phone calls from health professionals and customers inquiring as to the level of manganese in their drinking water. While many suppliers are not presently required to do so, some water suppliers have already provided MassDEP with baseline manganese sample results. **To be ready to respond to questions on manganese, MassDEP strongly recommends that, if you have not already done so, you voluntarily collect manganese baseline samples now.** For PWS with no manganese sampling results in the last twelve months, MassDEP will be adding mandatory baseline sampling for manganese to their sampling schedules for the 2014 – 2016 sampling period.

Manganese baseline monitoring must include sampling of finished (treated) water, representing each source at each entrance point to your distribution system. Samples should be analyzed using one of the USEPA-recommended methods for Secondary Drinking Water Contaminants listed at www.epa.gov/safewater/methods. The current list includes the following methods for manganese: USEPA Methods 200.5, 200.7, and 200.8 and Standard Methods 3111B, 3113B, and 3120B. MassDEP does not certify laboratories for the analysis of manganese in drinking water, so the analysis should be performed by a laboratory that is MassDEP-certified for the analysis of other drinking water metals using the same method it intends to use for the analysis of manganese.

The approximate per sample cost of analysis is between $15 and $30. Results should be reported to MassDEP. After MassDEP receives your results, we will contact you with any follow-up action you may need to take.

For more information on the MassDEP manganese baseline monitoring and public health initiative please see the attached: "**Manganese Monitoring Information Sheet.**" Please note that the health risk (and the MassDEP action plan) applies to all types of PWS (community and non-community, transient and non-transient).

To further assist PWS, MassDEP will be offering training/technical assistance for PWS on the issue of manganese in drinking water. An announcement for the training and technical assistance will be emailed to all PWS. If you have not been receiving emails from the Drinking Water Program please inform us of your email address at program.director-dwp@state.ma.us. In the subject line type Add my system's email address. In the body of the email you should include your name, title, PWS name and PWS ID#.

MassDEP sincerely appreciates your continued commitment to protecting public health and providing safe water to your customers. If you have additional questions on manganese or this letter please contact the following staff:

Region	**Name**	**Phone**	**Email**
WERO	Jim Gibbs	413-755-2299	James.Gibbs@state.ma.us
CERO	Paula Caron	508-767-2719	Paula.Caron@state.ma.us
NERO	Hilary Jean,	978-694-3229	Hilary.Jean.@state.ma.us
	Sean Griffin	978-694-3404	Sean.Griffin@state.ma.us
SERO	Allison Rescigno	508-946-2763	Allison.Rescigno@state.ma.us
Boston	Margaret Finn	617-292-5746	Margaret.Finn@state.ma.us

For more information on manganese in drinking water please visit our webpage:
http://www.mass.gov/eea/agencies/massdep/water/drinking/lead-and-other-contaminants-in-drinking-water.html#9

To see the USEPA's Drinking Water Health Advisory for Manganese please visit:
http://www.epa.gov/safewater/ccl/pdfs/reg_determine1/support_cc1_magnese_dwreport.pdf

You may also contact the Drinking Water Program at program.director-dwp@state.ma.us.

Yours truly,

Yvette DePeiza
Program Director,
Drinking Water Program, MassDEP

APPENDIX B

MADEP POLICY 92-05 STATUS OF DRINKING WATER SOURCES

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
ONE WINTER STREET, BOSTON, MA 02108 617-292-5500

ARGEO PAUL CELLUCCI
Governor

JANE SWIFT
Lieutenant Governor

BOB DURAND
Secretary

LAUREN A. LISS
Commissioner

Bureau Of Resource Protection
Division Of Water Supply (DEP/BRP/DWS) Policy 92-05
Procedure for Determining The Activity Type And Status of A Drinking Water Source
(Year 2000 Printing)

Revision Date: 8-1-96
Program Applicability
Supersedes Policy, SOP or Guidance #:
Approved by: Arleen O'Donnell

Policy, SOP or Guideline # 92-05

Background and Rationale

This policy is designed to provide guidance in interpreting the source activity type, availability code in the Water Quality Testing System (WQTS), monitoring requirements and special permit requirements of public drinking water sources as defined in 310 CMR 22.02.

Policy

The Division of Water Supply defines public water supplies, their testing and permit requirements as follows:

SOURCE TYPE(S)	AVAILABILITY (WQTS)	MONITORING REQUIREMENTS	SPECIAL PERMIT REQUIREMENTS
Primary Back-up Standby Seasonal	Active[1] (Former WQTS Codes: Permanent, Backup, Seasonal, Interim, Provisional)	As required by 310 CMR 22.00 and DEP Approval And DEP Approval Letters	None
Inactive (Off-line)	Inactive (Former WQTS Codes: Other, Contaminated)	None[2]	Source may not be brought on-line without DEP approval
Emergency[3]	Emergency	As specified by DEP at time of request for emergency use 4.	Emergency Declaration regulation applies MGL 21G § 15, 16, 17 and DWS Policy 87-05
Abandoned Declassified	Abandoned (Former WQTS Codes: Other)	None	Requires DEP approval to either declassify or abandon (in accordance with 310 CMR 22.25 and appropriate guidelines)

1. If the well has not been on line it must be sampled after stabilization occurs. It must be pumped at a rate approaching the production rate for 20 minutes. After 20 minutes begin taking and recording temperature readings at 5 minute intervals. The well water quality is considered to be stabilized when three consecutive temperature readings do not vary more than 5%. (Example: reading #1 = 50 °F; reading #2 = 51 °F; reading #3 = 5x2.5 ° F. Stabilization has occurred because the variation between readings #1 and #3 = 2.5 ° or 5%).

   Surface water sources may be sampled at the disinfection station.

2. This category will include both sources deliberately taken off-line (example: for scheduled maintenance) and sources which unexpectedly go off-line. PWSs must notify DEP when a source goes off-line if it is expected to miss any scheduled sampling. This notification should occur soon after the source goes off-line but prior to missing any scheduled sampling.

3. An emergency source may be any source that could be used during an emergency.

4. If a public water supply designates a source as an active (or maintained) emergency source, it must develop and submit to DEP a maintenance plan and a protocol for its use. This information must be included in its emergency response plan. The wellhead and watershed area must be maintained and periodic sanitary surveys done. However, it may only be connected into the system with DEP permission.

DWS must retain all public drinking water sources in its inventory according to their activity status.

Adopted: 8-07-96
Effective: 8-07-96

Arleen O'Donnell, Assistant Commissioner
Bureau of Resource Protection

Clunie, William

From: Persky, James (DEP) [james.persky@state.ma.us]
Sent: Tuesday, March 04, 2014 9:00 AM
To: Clunie, William
Cc: Zessoules, Nicholas (DEP)
Subject: RE: Ipswich MA wells
Attachments: Policy 92-05.pdf

Bill,

Nick Zessoules passed on your e-mail to me.

If a well is downgraded to "Inactive" status for **five years** or more, MassDEP will require portions of the New Source Approval to be done as it deems necessary before giving approval to return the well to service. This could potentially make it difficult to re-activate a well.

However, a Town can maintain an official "Active" status for a well even when it is not actually being used, by continuing to collect all of the required chemical samples for the well on its sampling schedule. There are a few Towns in the Northeast Region that are maintaining their rights to wells that have been off-line for years by doing this. The well is pumped to waste before sample collection, as described in the attached policy. It is not necessary to collect bacteria samples from the well while it is off-line.

The only Ipswich wells that are presently listed as "Inactive" are Winthrop #1 and Winthrop #3, which were both downgraded in years past, before the manganese issue arose.

James Persky
MassDEP Drinking Water Program
Northeast Regional Office
(978) 694-3227
FAX (978) 694-3498

From: Clunie, William [mailto:William.Clunie@aecom.com]
Sent: Monday, March 03, 2014 3:03 PM
To: Zessoules, Nicholas (DEP)
Subject: Ipswich MA wells

Hello Nick

I am working with the Town of Ipswich regarding their groundwater manganese issue. Specifically, I am preparing a listing of short term and long term recommendations that the Town can use in mitigating the high manganese from a few of their wells. One obvious recommendation will be to favor the better quality wells over the others which traditionally have higher manganese.

The Town has already inactivated one of the wells due to water quality concerns. However, if I am not mistaken, I believe MADEP has a policy whereby if a well or source is not used for a certain length of time, it runs the risk of being permanently eliminated as an approved withdrawal. Is this the case, and if so do you have any details on this policy? The Town would like the ability to rotate wells but not if it could result in loss of approved withdrawals.

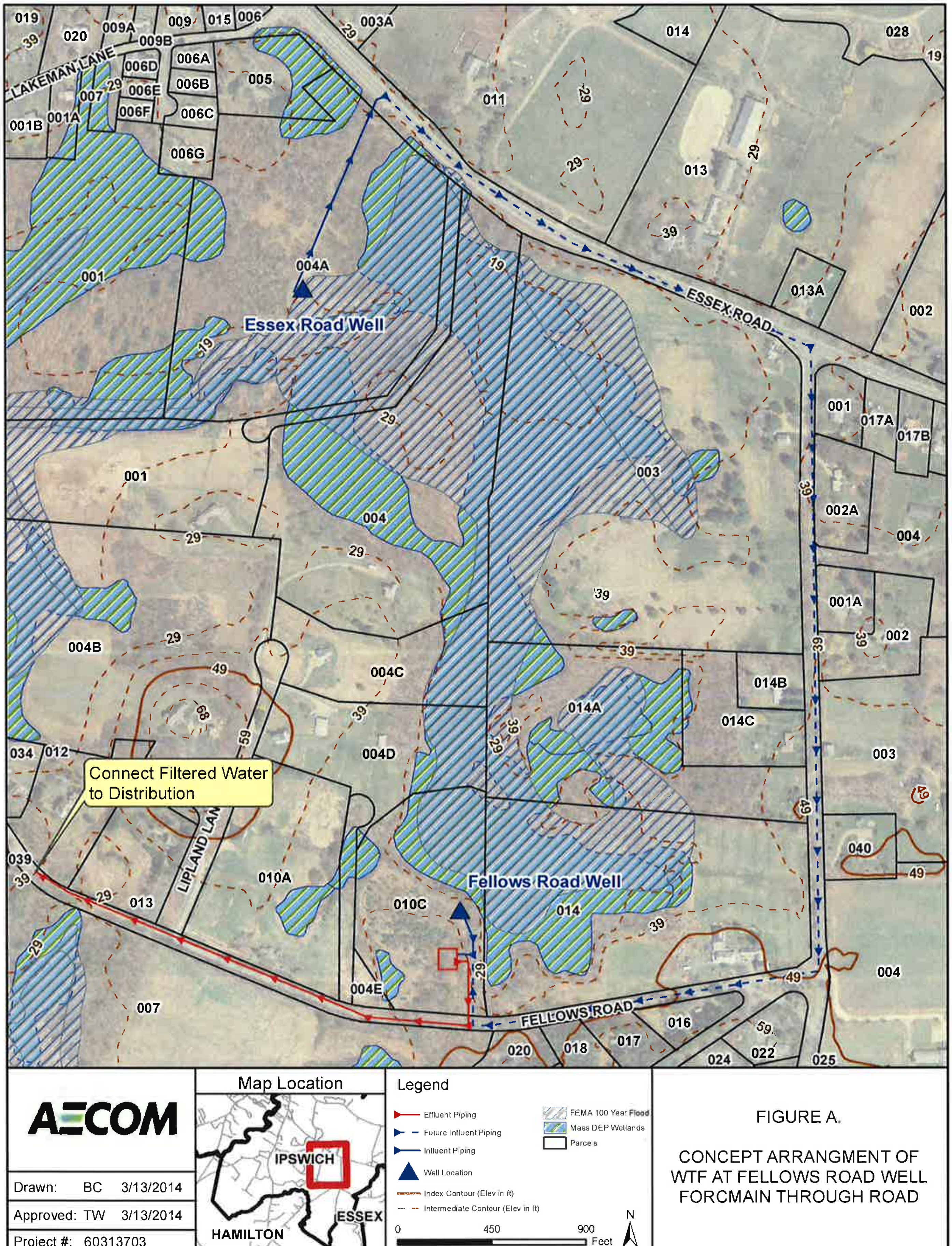
Bests,
Bill

William Clunie, P.E., BCEE
Technical Manager, Water
D 781.224.6145
C 617.331.1909
F 781.224.6546
william.clunie@aecom.com

AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com

APPENDIX C

CONCEPTUAL SITING LOCATIONS FOR GREENSAND TREATMENT SYSTEMS



G:\Projects\MUNI\60313703IPW\Maps\EX Conditions Map - Fellows Road - Essex Road Well.mxd

AECOM

Drawn:	BC	3/13/2014
Approved:	TW	3/13/2014
Project #:	60313703	

Map Location

Legend

- Well Treatment Options
- Well Location
- Index Contour (Elev in ft)
- Intermediate Contour (Elev in ft)
- Parcels
- FEMA 100 Year Flood
- Mass DEP Wetlands

N

0 250 500 1,000

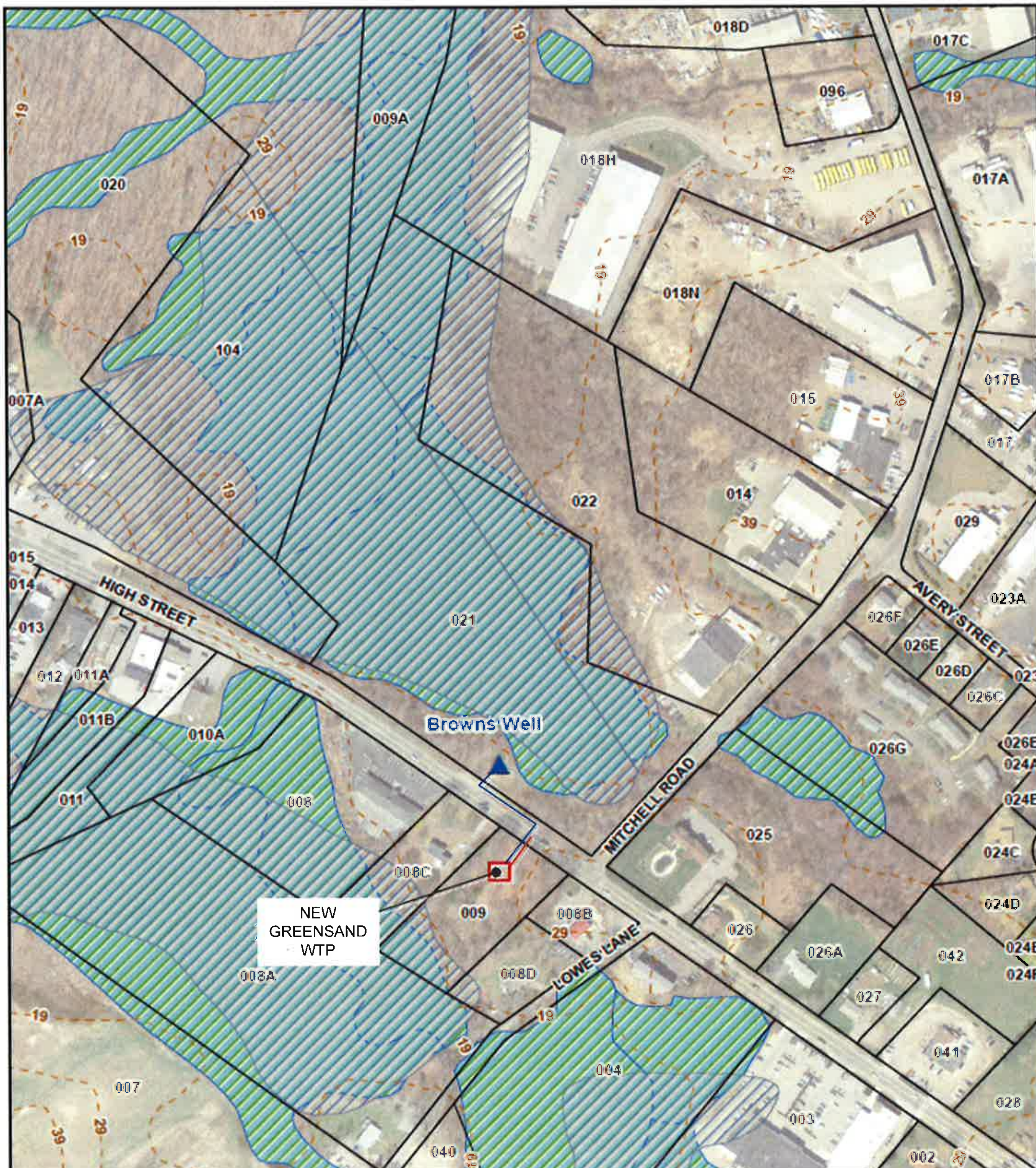
Scale in Feet

FIGURE B

BROWNS WELL TREATMENT OPTIONS

IPSWICH, MASSACHUSETTS

G:\Projects\MUNI\60313703\IPW\Maps\EX Conditions Map - Browns - Miles - WTP.mxd



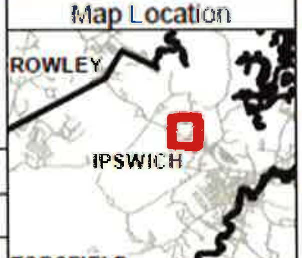
AECOM

Drawn: BC 1/16/2014

Approved: TW 1/16/2014

Project #: 60313703

Map Location



Legend

- Parcels
- Well Location
- Index Contour (Elev in ft)
- Intermediate Contour (Elev in ft)
- FEMA 100 Year Flood
- Mass DEP Wetlands

0 200 400 Feet

N

FIGURE C
CONCEPT SITING FOR NEW WATER TREATMENT SYSTEM FOR BROWNS WELL

TOWN OF IPSWICH

C:\Projects\Ipswich\Maps\EX Conditions Map - Browns Well.mxd

APPENDIX D

BUDGETARY PROPOSAL FOR GREENSAND FILTER SYSTEM AND CONCEPTUAL BUILDING LAYOUT

Roberts Water Technologies, Inc. *A Unit of the Roberts Filter Group*
SERVING THE WATER COMMUNITY

214 North Jackson Street
Media, PA 19063
www.robertsfilter.com
610-583-3131
fax 610-583-0117

January 27, 2014

AECOM
701 Edgewater Drive
Wakefield, MA 01880

Attention: Timothy Wassell, P.E.

Reference: Ipswich, Massachusetts

Subject: Roberts' Budget Proposal BP-14-1319-T

Gentlemen:

Roberts Water Technologies, Inc. ("Roberts") is pleased to offer the below budget scope of supply for the referenced project.

Pressure Filter System

Filter Tanks:

1. Two (2) - 84" OD Vertical Pressure units shall be furnished. Vessels shall be designed and fabricated in accordance with the ASME Code for a 100 psig working pressure (130 psig test pressure) and shall be so certified and stamped. Each tank shall be fabricated with tank connections, manway, lifting lugs, and structural supports.

2. Tank interior surfaces shall be blasted, primed and finish coated. Tank exterior surfaces shall be blasted, and primed only.

Inlet Distributor/Backwash Collector:

1. Two (2) sets of Inlet Distributor/Backwash Collectors shall be furnished. Each assembly shall be fabricated with XH steel arms and malleable iron fittings and shall be installed by others.

Air Scour System:

1. Two (2) sets of Air Wash Distributors assemblies fabricated of Schedule 80 PVC shall be furnished for assembly and installation by others.

Underdrain:

1. Two (2) sets of filter underdrain assemblies shall be furnished for assembly and installation by others. Underdrain headers and laterals shall be fabricated of Schedule 80 PVC with Type 304 stainless steel Macrobaffle Strainers.

   Note:
   a. Concrete subfill is required to fill the bottom of each pressure vessel for the installation of the underdrains. The concrete subfill is not included and shall be furnished and installed by others.

Gravel Support Bed:

1. Support gravel shall be furnished for Contractor's placement in each filter. A sufficient quantity of gravel shall be furnished in five (5) grades for a total finished depth of 12".

   Notes:
   a. Support gravel shall conform to the applicable standards of AWWA B100 and shall be NSF 61 Listed.
   b. All gravel shall be shipped in one (1) cubic foot bags on pallets.

Filter Media:

1. Greensand Plus shall be furnished for Contractor's placement in each filter. Greensand Plus shall be provided in sufficient quantity to obtain a finished depth of 18" within each filter and shall have an effective size of 0.30-0.35 mm with a maximum uniformity coefficient of 1.4 to 1.6.

2. Anthracite shall be furnished for Contractor's placement in each filter. Anthracite shall be provided in sufficient quantity to obtain a finished depth of 18" within each filter and shall have an effective size of 0.70-0.80 mm with a maximum uniformity coefficient of 1.65.

Notes:

a. Greensand Plus and anthracite shall conform to the applicable standards of AWWA B100 and shall be NSF 61 Listed.

b. Greensand Plus and anthracite shall be shipped in one (1) or one-half (1/2) cubic foot bags on pallets.

Valves:

1. Hydraulically operated diaphragm valves shall be furnished for Influent, Effluent, Backwash Inlet, Backwash Waste, Filter to Waste, Air Pressurization, Air Wash Control, Draindown and Backwash Flow Control.

2. Manually operated butterfly valves shall be furnished for Raw Water Isolation, Backwash Supply Isolation, Finished Water Isolation and Air Wash Isolation.

Flow Elements & Transmitters:

1. Two (2) - "Filter Effluent" magmeters including transmitters shall be furnished.

2. One (1) - "Backwash Flow" magmeter including transmitter shall be furnished.

Air Valves:

1. Two (2) automatic air release valves shall be furnished.

Pressure Gauges:

1. Four (4) - 4 1/2" pressure gauges with gauge cocks shall be furnished.

2. Two (2) "Filter Loss of Head" transmitters shall be furnished.

Sample Valves:

1. Twelve (12) sample valves shall be furnished.

Filter Face Piping And Fittings:

1. The face piping for each filter shall be furnished. Process piping shall be Class 53, flanged ductile iron pipe with internal cement lining and bituminous seal coat. Ductile iron pipe and fittings shall be furnished with prime painted exterior.

2. The face piping for the air supply shall be furnished fabricated of Schedule 5, Type 304L stainless steel.

Filter System Accessories

1. One (1) positive displacement air blower package shall be furnished. Air blower shall be sized to deliver 77 scfm at 6 psi. Blower package shall include blower, motor, inlet filter, inlet silencer, flexible couplings, base, discharge silencer, v-belt drive, discharge pressure gauge, discharge temperature gauge, discharge pressure switch, manual isolation wafer butterfly valve, and check valve.

Filter Control Panel:

1. One (1) Filter Control Panel (NEMA 12) shall be furnished for control of the two (2) filters. Control panel shall include Programmable Logic Controller (PLC) with Operator Interface Terminal, UPS, programming software, and all required switches, indicator lights, numeric displays, nameplates, internal wiring, terminal blocks, and associated components.

Supervisory Services:

1. Field service shall be furnished for controls coordination meeting, installation supervision, startup assistance and operator training.

Budget Price:

$395,700.00 – Three Hundred Ninety Five Thousand, Seven Hundred Dollars

We thank you for the opportunity of submitting this quotation. If you should have any questions, please contact the undersigned or our representative copied below.

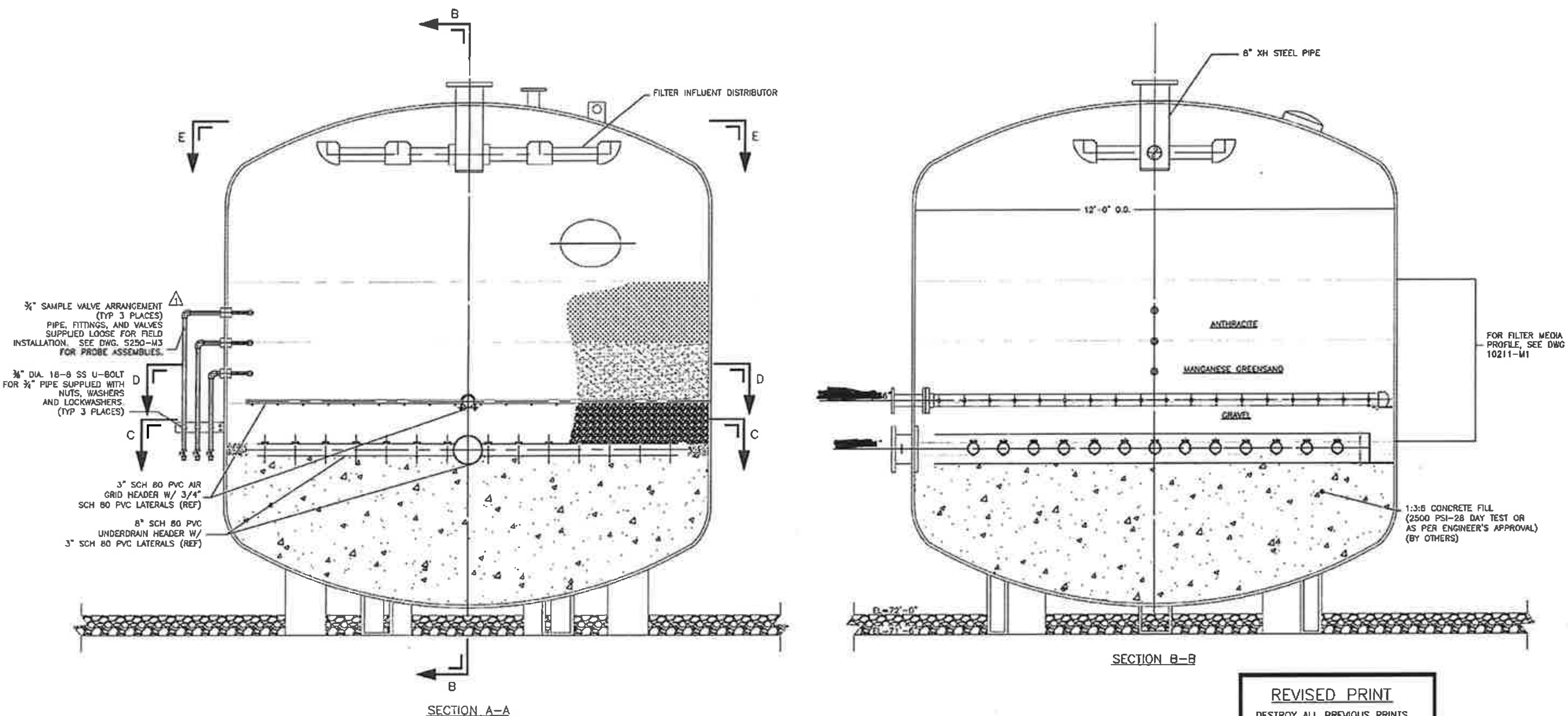
Respectfully submitted,
ROBERTS WATER TECHNOLOGIES, INC.

Andrew S. Taylor
National Sales Manager

AST:kpr

CC: Mr. Mike Brillion, Bartlett & Brillion, (508) 668-1337

NOTES:
1. SEE DRAWING S149-M3 FOR PLAN VIEW SECTION D-D OF THE PVC AIR GRID.
2. SEE DRAWING S149-M7 FOR PLAN VIEW SECTION E-E OF THE INLET DISTRIBUTOR.
3. SEE DRAWING S149-M8 FOR PLAN VIEW SECTION C-C OF THE HEADER/LATERAL UNDERDRAIN.



REVISED PRINT

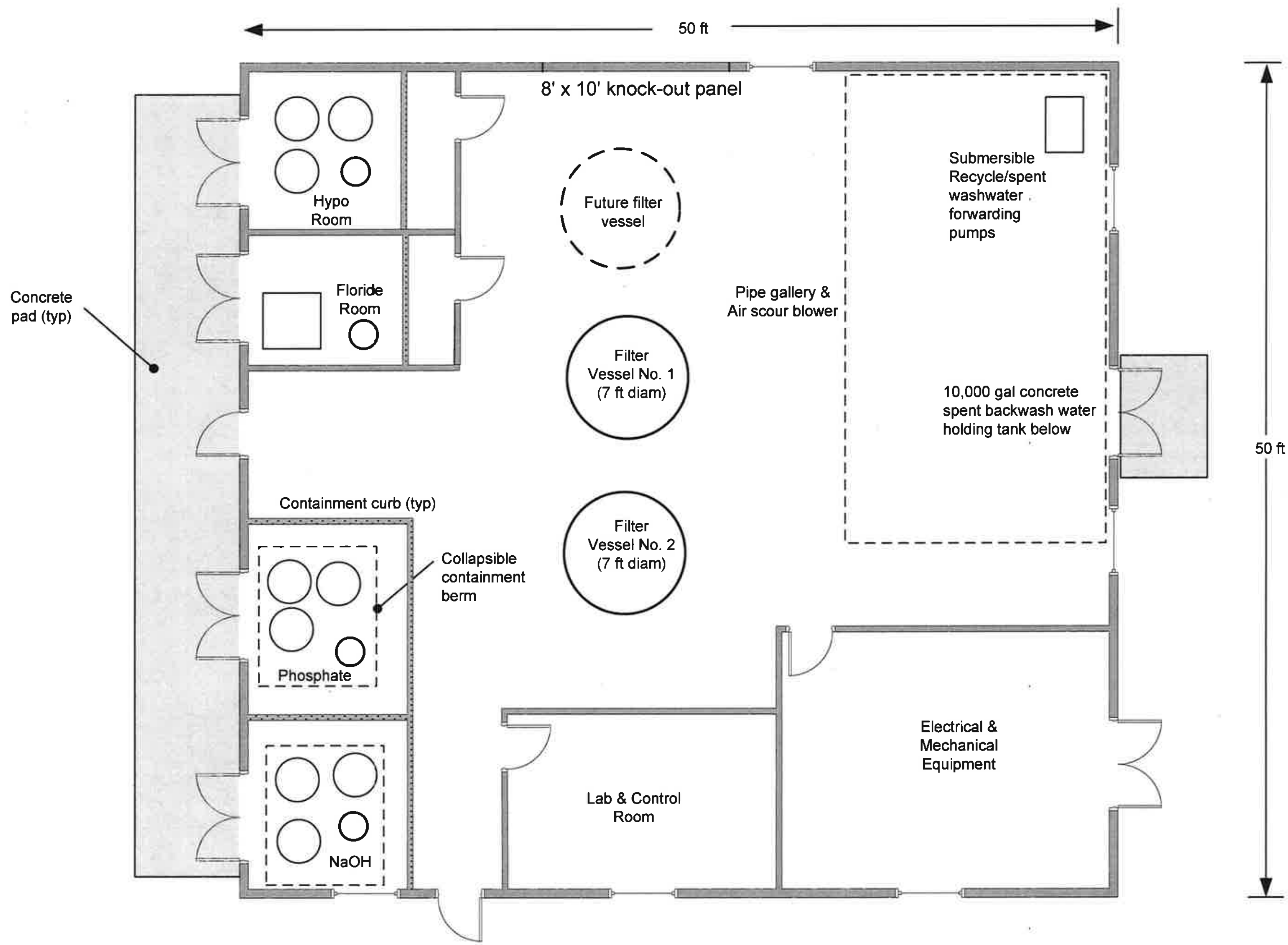
DESTROY ALL PREVIOUS PRINTS OF THIS NUMBER
ROBERTS FILTER MFG. CO.
DARBY PA.

DATE: 5/19/03

ROBERTS WATER TECHNOLOGIES, INC.
6TH STREET AND COLUMBIA AVE.
DARBY PENNSYLVANIA 19023

FILTER INTERNAL SECTIONS FOR A 12'-0" OD X [redacted] STRAIGHT SIDE VPF

SCALE 3/4"=1'
CONTRACT 3322-7
DWG NO. 8017-M2



PLOT DATE: 3/21/14

SCALE: 1/8 inch per ft

AECOM

Conceptual Filter Building Layout

IPSWICH UTILITIES DEPARTMENT
Concept Layout of Greensand Filter Building for Manganese Removal

APPENDIX B

AECOM
AECOM
701 Edgewater Drive
Wakefield, MA 01880
www.aecom.com
781 246 5200 tel
781 245 6293 fax

November 26, 2014

Ms. Vicki Halmen,
Water and Wastewater Manager
Ipswich Utilities Department
272 High Street
P.O. Box 151
Ipswich, MA 01938

Re: Proposed Scope of Services
Replacement Well Options
Brown's Well

Dear Ms. Halmen:

As you requested, AECOM has prepared the proposed scope of services for evaluating a replacement well source for the Brown's Well.

Our proposal is presented as a set of options with associated costs for the consideration of you and your Board. The first two options are intended as a means of evaluating the source(s) of the excessive levels of dissolved manganese in Brown's well. The second two options are aimed at identifying the location for a replacement source of water.

Proposed Scope of Services

<u>I. Investigate Beaver Dams</u>
Overall Goal - Map the location of the beaver dams on Muddy Run in support of Water Department efforts to obtain approval to remove the dams.

1. Perform a one-day reconnaissance survey by boat to observe the locations of the beaver dams on Muddy Run in the vicinity of the Brown's Well north of MA State Highway Route 133. Obtain GPS locations and photographs of beaver dams and other significant features. Observe and record the extent of flooding caused by the beaver dams, especially in the clay pit behind Brown's Well. Obtain water-depth measurements in the clay pit. AECOM will provide a boat and two-man crew.

<u>II. Investigate Potential Sources of Dissolved Manganese</u>
Overall Goal - Map the concentrations of manganese in the groundwater and surface water surrounding Brown's well in an effort to identify the geographic source(s) of the manganese.

1. Collect water samples from up to two depths (surface and bottom) in the following surface water bodies: clay pit pond, Muddy Run north of Route 133, Muddy Run south of Route 133 and the pond on Lowes Lane. Test samples for total and dissolved iron and manganese (laboratory) and selected field parameters (pH, conductivity, oxidation-reduction potential, dissolved oxygen, and temperature).

2. Provide the services of a well-drilling contractor to install up to three shallow (4 to 5 feet depth) driven well points in: a) the clay pit pond behind Brown's well, b) in the pond at Lowes Lane, and c) in Muddy Run directly north of Route 133. Collect water samples from these drive points and test them for total and dissolved iron and manganese (laboratory) and selected field parameters (pH, conductivity, oxidation-reduction potential, dissolved oxygen, and temperature). Obtain GPS locations of these drive points.

3. Provide the services of a well-drilling contractor to pump up to six (6) existing monitoring wells near Brown's well, collect water samples and test the samples for total and dissolved iron and manganese (laboratory) and selected field parameters (pH, conductivity, oxidation-reduction potential, dissolved oxygen, and temperature). Obtain GPS locations of these wells. The Water Department will locate and mark these wells in the field in advance. The following wells are expected to be tested: MW-1, MW-2, MW-3, MW-5, OW-3 and OW-4.

4. Collect water samples from the Brown's Well and Mile Lane well and test the samples for the following parameters:
    a. Field – pH, specific conductance, dissolved oxygen, temperature, oxidation-reduction potential, CO_2, turbidity
    b. Field – BART kit, multiple bacteria
    c. Laboratory – pH, specific conductance, Total Fe, Mn, Ca, Mg, K, Na, dissolved Fe and Mn, alkalinity, hardness, ammonia, SO_4, NO_3, Cl, TOC, Fe-bacteria.

5. Tabulate water quality results and prepare a letter report with maps summarizing our investigations and findings.

III. Test Well Investigation – Brown's Well

Overall Goal – Offer an opinion on a potential location for a replacement well for Brown's Well. This would include not only a location within 25 feet of the existing well, but also on Town land across Route 133, 250 feet from the existing well. Compare the results of water-quality and well-yield testing at each of these sites, and offer an opinion on which is more advantageous to the Town.

1. Obtain quotations for well drilling services and contract with a well drilling contractor.
2. Provide the services of a well-drilling contractor to install 2-inch diameter test wells at two locations: approximately 25 feet from Brown's well and 250 feet from Brown's well. Estimate 250 linear feet of well drilling, which assumes up to five (5) test wells. This includes two test-well pairs (one pumping well and one observation well two feet from the pumping well), plus one additional test well, if necessary, each approximately 50 feet deep.
3. Provide the services of a well-drilling contractor to install up to five (5) well screens and develop them to remove fines.
4. Provide the services of a well-drilling contractor to pump up to (2) selected test wells for a period of 2 to 6 hours and observe drawdown in the 2-foot observation well. Observe water

levels in other available test wells. Offer an opinion on the potential yield of a large-diameter gravel-packed well.

5. Collect water samples at the conclusion of the pumping tests from each of the two (2) well sites, and submit the samples to a qualified analytical laboratory for testing of routine inorganic and aesthetic parameters (including secondary drinking water parameters), nutrients, bacteria and VOCs. Test the water samples in the field for pH, specific conductance, dissolved oxygen, oxidation-reduction potential, and temperature.
6. At the conclusion of pumping, observe water-level recovery.
7. Observe the test drilling on a part-time basis. Classify soil samples, assist in selecting well screens, observe the pumping tests and collect water samples for laboratory and field water-quality testing.
8. Perform a GPS survey of test-well locations and other features. Prepare a map of the test well locations and other relevant features on an aerial photo base map.
9. Prepare a letter report summarizing the results of test-well drilling, including well construction details, pumping rates, specific capacity and water-quality. Offer an opinion on the well yields for large-diameter gravel-packed wells. The report will also include an opinion of cost for permitting, design and construction of a replacement well at each location, including a building, water main and electrical power.

IV. Test Well Investigation – Ross Property

Overall Goal – Offer an opinion on a potential location for a replacement well on the Ross Property west of the existing Brown's Well. Because the Ross Property is more than 250 feet from the Brown's well, if a replacement-well location is found, it would be subject to the Massachusetts Department of Environmental Protection's New Source Approval process.

1. Review available surficial geologic mapping and aerial photographs of the property and its surroundings, along with property boundary mapping, and recommend general areas for investigation.
2. Make a site visit with Water Department representatives to review site conditions, access, and other relevant features.
3. Provide the services of a geophysical contractor to perform up to three (3) days of geophysical surveys to evaluate the thickness and character of the surficial soils and depth to bedrock, including any "buried valleys" similar to that found at the Brown's well. Recommend locations for test well drilling. If a location is not identified through the geophysical surveys, the investigation may stop at this point.
4. Obtain quotations for well drilling services and contract with a well drilling contractor.

5. Provide the services of a well-drilling contractor to install 2-inch diameter test wells at selected locations. Where suitable water-bearing soils are found, install an observation well two feet from the test well for a short-term pumping test. Estimate 400 linear feet of well drilling, which assumes up to eight (8) wells, each 50 feet deep.
6. Where suitable water-bearing soils are found, provide the services of a well-drilling contractor to install up to eight (8) well screens and develop them to remove fines.
7. Provide the services of a well-drilling contractor to pump up to four (4) selected test wells for a period of 2 to 6 hours and observe drawdown in the 2-foot observation well. Observe water levels in other available test wells. Offer an opinion on the potential yield of a large-diameter permanent well.
8. Collect water samples at the conclusion of the pumping tests from each of the two (2) well sites, and submit the samples to a qualified analytical laboratory for testing of routine inorganic and aesthetic parameters (including secondary drinking water parameters), nutrients, bacteria and VOCs. Test the water samples in the field for pH, specific conductance, dissolved oxygen, oxidation-reduction potential, and temperature.
9. At the conclusion of pumping, observe water-level recovery.
10. Observe the test drilling on a part-time basis. Classify soil samples, assist in selecting well screens, observe the pumping tests and collect water samples for laboratory and field water-quality testing.
11. Perform a GPS survey of test-well locations and other features. Prepare a map of the test-well locations and other relevant features on an aerial photo base map.
12. Prepare a letter report summarizing the results of geophysical surveys, test-well drilling, short-term pumping tests and water-quality. Offer an opinion on the potential well yields for a large-diameter gravel-packed well. The report will also include an opinion of cost for permitting, design and construction of a replacement well at each location, including a building, water main and electrical power.

Estimated Costs

The following are AECOM's estimated costs for the services described above:

I. Investigate Beaver Dams
For the scope of services outlined above, AECOM suggests the Town budget $5,500.

II. Investigate Potential Sources of Dissolved Manganese
For the scope of services outlined above, AECOM suggests the Town budget $21,500.

III. Test Well Investigation – Brown's Well

For the scope of services outlined above, AECOM suggests the Town budget $51,500

IV. Test Well Investigation – Ross Property

For the scope of services outlined above, AECOM suggests the Town budget $97,000

We would be happy to discuss the scope of services with you in more detail. If you decide to move forward with the full program as outlined or a part of the program, please let us know and we will prepare and forward to you a professional services agreement for execution.

We appreciate the opportunity to be of continued service to the Town of Ipswich, and look forward to hearing from you.

Very truly yours,
AECOM

Donald Chelton

Donald Chelton
Vice President